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OF PENNSYLVANIA.

No. XXIII.

ON THE VANADATES AND IODYRITE,

From Lake Valley, Sierra Co., New Mexico.

BY F. A. GENTH AND GERHARD VOM RATH.

(Read before the American Philosophical Society, April 17, 1885.)

At a meeting of the American Institute of Mining Engineers, held at Washington, D. C., in 1882, the late Prof. Benj. Silliman read a paper "On the Mineral Regions of Southern New Mexico,"* in which he gave the first fuller information about the extraordinary occurrence of rich silver ores and the accompanying minerals in the mines of the so-called Sierra Group, comprising the Sierra Grande, Sierra Bella and Sierra Apache.

The geological position had been determined in 1881 by Prof. E. D. Cope, when he showed that the strata in which the ores occur belong to the lower coal measures.

The ores form a bed more or less interrupted, or rather, a series of huge lenticular beds or pockets between the limestone strata, which show a dip of about 30° towards the S. E. This dip flattens to one of only about 15° at a depth of 180 feet. The ore bed is frequently divided by intercalations of limestone strata.

The foot wall consists of a hard, more or less siliceous, blue limestone, with very few fossils, into which the ores frequently penetrate, as if by alteration of the bed rock. The hanging wall is formed by a pale slaty limestone without siliceous inclosures, rich in fossils, but without any ores. The separation between the hanging wall and the ore bed is perfect.

The main body of the ores is formed by oxides of iron and manganese: hematite, limonite, pyrolusite, manganite, psilomelane, and wad, intermixed with variable quantities of cerargyrite and embolite, together with small quantities of native silver and highly argentiferous cerussite and galenite. At many places the upper portion of the ore bed consists of flint and siliceous minerals which cover the argentiferous iron ores, and which are sometimes rich in embolite; pale yellow crystals of vanadinite in druses of quartz are sometimes met with.

These facts, mostly taken from Prof. Silliman's paper, give a brief

* Engineering and Mining Journal, New York, Oct. 14 and 21, 1882, pp. 199 and 206; 212, 213 and 214.

account of the geological position and the accompanying minerals which he had observed.

A few months ago a highly interesting find was made at the Sierra Grande, which furnished some beautiful specimens of very rare species, of which we received a sufficient supply for investigation from Mr. N. H. Muhlenberg, in Lake Valley, and his representative in Reading, Pa., Mr. Theodore A. Kendall, to whom we are greatly indebted for their liberality, also to Mr. Robt. C. Canby, at Pueblo, Col., who has kindly furnished the writer with the vanadinite from the Sierra Bella.

In the following investigation the crystallographic measurements and figures are by Gerhard vom Rath, and the analyses, &c., by F. A. Genth.

It may be well to give a general outline of the methods employed for the analyses of the vanadates, described in this paper.

After dissolving in very dilute nitric acid, the insoluble residue was filtered off, then treated again two or three times with dilute nitric acid in order to bring all the vanadates into solution. This was especially necessary in the case of the dark descloizites, but, notwithstanding this, some of the constituents of this mineral remained undissolved, and appreciable quantities of lead, copper and zinc were retained, probably by the manganese dioxide which was present in considerable quantities. These bases were determined and their quantity added to the main portion.

In the filtrate the chlorine was precipitated by a few drops of silver nitrate, the excess of silver removed by just enough hydrogen chloride and the filtrate from the silver chloride evaporated nearly to dryness. A large excess of strong hydrogen sulphide water was then added and the beaker put at a warm place for two days. Lead, copper and arsenic were precipitated as sulphides, but also, invariably more or less zinc,* although the solution was still strongly acid. After two days' standing, the solution had yet a strong odor of hydrogen sulphide. It was filtered off, and the arsenious sulphide separated from the sulphides of lead, copper and zinc, by digestion with sodium hydrate, the filtrate precipitated with hydrogen chloride; the arsenious sulphide, thus obtained, oxydized with strong nitric acid into arsenic acid, which was weighed as pyro-arsenate of magnesium. The precipitate containing lead, copper and part of the zinc as sulphides, was oxydized with strong nitric acid, sulphuric acid was then added and evaporated until the nitric acid was completely expelled. In the filtrate from the lead sulphate the copper was precipitated as sulphide and weighed as oxide, and the zinc converted into sulphide, after neutralization with ammonia, and added to the main portion.

The filtrate from the first hydrogen sulphide precipitate was evaporated and the tetroxide of vanadium re-converted into vanadic acid by the nitric acid present, whereupon, the solution was boiled with sodium carbonate to separate the zinc, manganese and iron from the *greater* part of the

*In the analysis of descloizite, a2, the zinc was lost, because the filtrate from the lead sulphate which contained a portion of it, was accidentally thrown away.

vanadic and phosphoric acids. As this separation is not complete, the precipitate was fused with sodium carbonate and lixiviated with water, after having reduced the manganic acid by a few drops of alcohol. Iron was separated from zinc and manganese by sodium acetate, the zinc precipitated by hydrogen sulphide from the cold filtrate, after acidulating strongly with acetic acid, and finally the manganese by sodium carbonate. In the united solutions, containing vanadic and phosphoric acids the sodium carbonate was nearly neutralized with acetic acid, and the two acids precipitated either by mercurous nitrate or lead acetate. In the first case the mercury was driven off at the lowest possible temperature, then a little nitric acid was added, the liquid evaporated to dryness, after which the residue, containing pentoxide of vanadium and metaphosphoric acid, was ignited; in the second place, the lead salt was mixed with a little nitric acid, the lead removed as sulphide, the filtrate evaporated and the residue ignited.

It now remained to separate the phosphoric acid from the vanadic pentoxide. They were dissolved in boiling hydrogen chloride, completely reduced by sulphurous acid, and after having added a little tartaric acid and a large excess of ammonia, precipitated with magnesia solution. On account of the minute quantity of phosphoric acid, the liquid was allowed to stand a long time in order to secure a complete precipitation, but, in doing this, a small quantity of the reduced vanadic acid was re-oxidized and contaminated the phosphate with a minute quantity of magnesium-ammonium vanadate. It was necessary, therefore, to re-dissolve in hydrogen chloride, and after addition of a little sulphurous and tartaric acids, to re-precipitate by ammonia, when a perfectly white pyrophosphate of magnesium was obtained.

Vanadinite.

Prof. Silliman was the first to observe vanadinite in pale, yellow hexagonal crystals at the Lake Valley Mines.

a. At the Sierra Bella it is found on wad in thin coatings, consisting of minute crystals of a brownish-yellow color which, under the microscope, show bright hexagonal prisms with the basal plane and the pyramid slightly indicated; powder yellow. Analysis a.

b. At the Sierra Grande several varieties are found.

1. Beautiful crystals, the largest not over 5^{mm} long and 2.5 to 3^{mm} thick; hexagonal prisms, terminated by the basal plane and the pyramid. The angle between the prism and pyramid was found by measurement to be nearly 130°. The planes are often rough, as if corroded by a solvent, and the crystals frequently show cavities, some appear as skeleton-like residues. Smaller crystals of about 1.5 to 2^{mm} in length are perfectly developed and show smooth brilliant faces. The color is orange-yellow, varying from wax-yellow on one side to a deep orange-red, the terminations being generally of the darkest color; cloudy. Powder pale orange-yellow. Lustre greasy, inclining to vitreous. Associated with pyrolusite

and implanted in calcite. Minute very brilliant columbine-red or cherry-red crystals of descloizite are implanted in, or crystallized upon the vanadinite and calcite, and may have been formed from constituents of decomposed or dissolved vanadinite. Analysis b1.

2. Other varieties of vanadinite are associated with the black or dark-brown descloizite. They all show the hexagonal prism and the basal plane, and most of the crystals the pyramid also; a more acute pyramid, and a prism and pyramid of the second order are rarely indicated. The planes are generally smooth and brilliant, but there are some, in which the basal plane is rough, as if corroded, but surrounded by a smooth and brilliant margin. The crystals vary in size from 1.5 to 3^{mm} in length and 0.5 to 2^{mm} in thickness. Their color is from orange-yellow to brownish-orange.

They are mostly of a more recent origin than the brown descloizite which they accompany; it appears, however, that the latter was still growing when this vanadinite and iodyrite were formed, since the large crystals of descloizite are frequently pitted by their impressions; the vanadinite and iodyrite seem to have crystallized simultaneously, but there are smaller crystals of descloizite of a red color of a more recent origin; they are attached to iodyrite, vanadinite and calcite.

Analyses:

a. As not enough of the pure mineral from the Sierra Bella could be obtained, an indefinite quantity of the incrustations upon wad was purified as much as possible by washing off the lighter particles and analyzed. It gave: 0.0153 grm Ag = 0.0050 grm Cl, 0.2261 grm PbSO₄, 0.0007 grm Mg₂As₂O₇, 0.0021 grm Mg₂P₂O₇ and 0.0364 grm V₂O₅.

b1. 1 grm gave: 0.0757 grm Ag = 0.0249 grm Cl, 1.0647 grm PbSO₄, and 0.1814 grm (VP)₂O₅; 1.5665 grm, after deducting 0.0008 grm quartz or 1.5657 grm pure vanadinite gave: 1.6669 grm PbSO₄, 0.0282 grm Mg₂As₂O₇, 0.0095 grm Mg₂P₂O₇ and 0.2779 grm V₂O₅. These quantities give the following percentage:

a. Sierra Bella.			b1. Sierra Grande.		
Sp. Gr. =	—	Atomic ratio.	6.862		Atomic ratio.
Cl	= 2.39—0.067	= 1	2.49—[2.49]—0.070		= 1
P ₂ O ₅	= 0.57—0.004	} = 0.100 = 1.49 }	18.14	— 0.39—0.006	} = 0.106 = 1.5
V ₂ O ₅	= 17.37—0.095		—17.74—0.097		
As ₂ O ₅	= 0.24—0.001		not det.—1.33—0.006		
PbO	= 79.43—0.356	= 5.31	78.36—78.31—0.351		= 5
ZnO	= —		— trace.		
			Less O,	100.26	
			Equiv. to Cl. =	0.55	
			99.71		

The analysis b1 corresponds exactly to the formula Pb₅Cl [(VAsP)O₄]₅ in which a small portion of the vanadium is replaced by arsenic and phosphorus, while analysis a shows a slight excess of lead which is probably present as cerussite.

Endlichite, or Vanadium-Mimetite, a new species.

In the collection of Mr. Clarence S. Bement was a specimen, labeled vanadinite, which showed such a peculiar appearance that its examination was desirable, for which purpose he has kindly loaned the same.

There are apparently three kinds of crystals present; some of an orange-yellow and orange-red color, probably vanadinite; the largest a little over 1^{mm} in size; they are hexagonal prisms with pyramid and, slightly developed, a second more acute pyramid; both the prismatic and the pyramidal planes are strongly striated through oscillation of the pyramidal planes with the prismatic; then there are one or two bright yellow very minute crystals, which are imperfect and appear as, if made up of several individuals; the planes are the same as those of the orange crystals. The third mineral is developed in the form of very bright straw-yellow crystals, showing the strong striation of the prismatic planes and the two pyramids. On the largest crystals, not over 1^{mm} in length, the basal plane is visible, on the small ones it is quite obliterated. A few of the crystals were hollow.

An imperfect qualitative analysis gave no satisfactory results on account of the exceedingly minute quantity at disposal. Fortunately Mr. Muhlenberg succeeded in securing for examination another small specimen which showed some peculiarities, but was evidently the same as Mr. Bement's specimen. Implanted in drusy quartz colored by ferric and manganic oxides, the crystals are yellowish-white or pale straw-yellow, the largest 3^{mm} long and from 0.5 to 1.5^{mm} thick, the forms are those given above. Some of the crystals show only a hollow prism, either empty, or filled with a crystalline powder which now and then assumes hexagonal forms. As the specimen contained only a very minute quantity which could not be picked out, an analysis was made from all the fragments of quartz which showed some of this mineral. On dissolving in dilute nitric acid a slight evolution of carbonic dioxide was observed.

0.9518 grms gave: 0.7276 grm insoluble quartz, etc., 0.0094 grm Fe_2O_3 , 0.0029 grm CaO , 0.0127 grm $\text{Ag} = 0.00417$ grm Cl , 0.0277 grm $\text{Mg}_2\text{As}_2\text{O}_7$, 0.0152 grm V_2O_5 , and an unweighable trace of $\text{Mg}_2\text{P}_2\text{O}_7$. This gives:

Quartz, &c.,	=	76.44 %	
Fe_2O_3	=	0.99	
CaO	=	0.30	
Cl	=	0.44	
As_2O_5	=	2.16	
P_2O_5	=	trace.	
V_2O_5	=	1.60	
PbO	=	15.94	
$\text{CO}_2, \text{H}_2\text{O}, \&c.$	=	2.13	by difference
		100.00	

Deducting the admixtures the pure mineral contains :

				Atomic ratio.
Cl	=	2.18	=	0.061
As ₂ O ₅	=	10.73	=	0.047
V ₂ O ₅	=	7.94	=	0.043
PbO	=	79.15	=	0.355
		100.00		

The small excess of lead is evidently owing to an admixture of cerussite, and the mineral is a combination of one molecule of mimetite with one molecule of vanadinite = $\text{Pb}_5\text{Cl}[\text{AsO}_4]_3 + \text{Pb}_5\text{Cl}[\text{VO}_4]_3$, corresponding to which is the following :

Cl	=	2.44
Pb	=	7.11
As ₂ O ₅	=	11.86
V ₂ O ₅	=	9.60
PbO	=	68.99
		100.00

The name has been suggested by Mr. N. H. Muhlenberg in honor of Dr. F. M. Endlich, Superintendent of the Sierra Mines at Lake Valley, N. M.

Since the above has been written Mr. Muhlenberg sent a new supply of endlichite which was different in appearance from that previously seen. It consisted of groups of crystals of a columnar structure, some radiating from a centre and also forming sheaflike aggregations. In many of them the hexagonal form could be distinctly seen, especially towards the diverging ends which show the basal plane and pyramid very distinctly. They are all strongly striated. The individual crystals are white and yellowish-white or straw-yellow, towards their terminations often changing to yellow and in a few groups to a deep orange red. The largest groups were 10^{mm} in length.

The whitest gave a spec. grav. of 6.864 and contained :

		Atomic ratio.	
Cl	=	2.45	0.069
PbO	=	73.48	0.330
CaO	=	0.34	0.006
As ₂ O ₅	=	13.52	0.087
V ₂ O ₅	=	10.98	0.084
P ₂ O ₅	=	trace	
		100.77	

From this the ratio of the constituents appears to be about the same as

found before, and that arsenic and vanadium are present in the proportion of 1 : 1.

The change of color of these groups of crystals, however, appears to indicate that the vanadiferous mimetite or endlicheite may gradually change into vanadinite.

Probably the same mineral has already been observed by Prof. Silliman at the Torrence Mine, Socorro, N. M., where it occurs in small yellow hexagonal prisms which were mistaken for vanadinite, but were mimetite containing vanadium.

Descloizite.

The writer has just received from Prof. Gerhard vom Rath the following communication which he gives in his own words :

“The recently discovered crystals of this rare species surpass in perfection and development by far those from previously known localities. They offered an opportunity to examine again the different opinions regarding their crystallographic system. (Des Cloizeaux, *Ann. de chimie et de physique*, 3 sér., 41, 78 and Websky, *Zeitsch. für Krystallographie* 5, 542.)

“If we retain the primitive form suggested by the distinguished French crystallographer, which has also been adopted by the celebrated Berlin Professor, changing the system, however, which Des Cloizeaux supposed to be rhombic, into monoclinic, we have these faces referred to the rhombic system :

“	o	=	(111),	P.
“	h	=	(132),	$\frac{3}{2}$ P
“	d	=	(012),	$\frac{1}{2}$ $\check{P}\infty$
“	f	=	(201),	2 $\bar{P}\infty$
“	m	=	(110),	∞ P
“	l	=	(130),	∞ $\check{P}3$
“	a	=	(100),	∞ $\bar{P}\infty$
“	b	=	(010),	∞ $\check{P}\infty$
“	c	=	(001),	o P

“The fundamental angles have been measured as follows :

“	0	:	0'	(brachydiagonal edge)	=	126° 56
“	0	:	0''	(macrodiagonal edge)	=	90 54

“thence the proportion of the orthogonal axes :

$$\check{a} : \bar{b} : c = 0.6267 : 1 : 0.8046.$$

	Calculated.		Measured.
" o : o (lateral edge)	= 112° 32½'		
" h : h (brachydiagonal edge)	= 88 51½		
" h : h (macrodiagonal edge)	= 136 6		
" h : h (lateral edge)	= 107 26		
" m : m (over a)	= 115 ½		
" l : l (over a)	= 55 16		
" o : m	= 146 16¼	146° 22'	
" h : l	= 143 43		
" d : d (over c)	= 136 10½	136 { ¼ 14	
" f : f (over a)	= 136 49½		
" m : l	= 150 7¼		
" d : o	= 133 ¼	133 12	
" f : o	= 148 56½		

"The pyramid h has, however, such minute faces, that accurate measurements were impossible.

"With great attention I treated the question whether our mineral be rhombic or monoclinic, having at my disposal a good crystal allowing measurements on one side as well as on the other side of the axis a (brachydiagonal). I found :

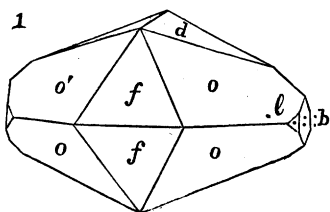
" o : o (in front)	= 126° 52'
" o : o (behind)	= 126 53
" o : o (behind)	= 126 55
" o : o (behind)	= 126 56

"Considering the development of the faces, this difference does not exceed the probable error. Besides, not having observed any indication of twinning, I thought it necessary to maintain the rhombic system, adopting Des Cloizeaux's opinion. Supposing Websky's views to be correct, the calculation of the two mentioned angles would give the following results :

" o : o (in front)	= 126° 43'
" o : o (behind)	= 126 16

"a difference which cannot exist in our crystals.

"The development of the New Mexican descloizites is different, as our figures 1-4 will show :



"Fig. 1 represents crystals of a dark red color (implanted), attached on a quartzitic gangue which is covered with psilomelane. The crystals reach 2mm in size and are very bright. A specimen of this kind was used for the measurements. The faces f are striated and dull.

" Fig. 2. The crystals reach 1^{mm} in size,
 " they are highly aggregated, sometimes so
 " thickly and in such subparallel position
 " that the faces seem to be broken. The
 " best specimen of this kind gave the fol-
 " lowing results :

" o : o (brachydiagonal edge) = 126° 45'

" o : m = 146 24

" Considering the minuteness of these crys-
 " tals and the fact that the reflection is not
 " sharply defined, this agreement can be
 " regarded as sufficient. They are attached
 " to a quartzitic gangue and of columbine
 " red color.

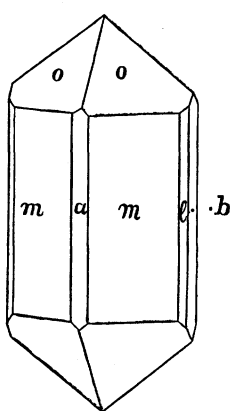
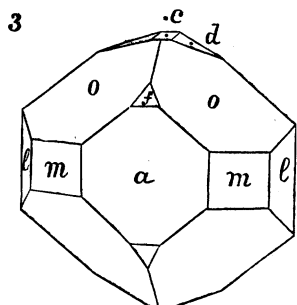
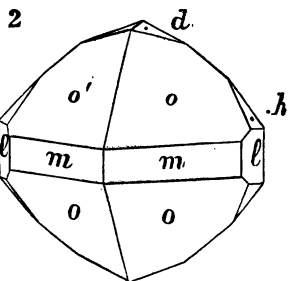
" Fig. 3 shows crystals of larger size,
 " reaching 8^{mm}. The faces are somewhat
 " uneven, blackish-red, opaque ; the plane
 " a striated by oscillation with f.

" Fig. 4. Wonderfully fine crystals with
 " the dominant prism m. Their size reach-
 " es 3^{mm}. Implanted on a quartzitic gan-
 " gue with pyrolusite.

" There is a distinct cleavage parallel to
 " face b, producing a reflection from the in-
 " terior of the crystals in this direction.

" Regarding the optical properties of des-
 " cloizite I take pleasure in communicating
 " the following lines from a letter of M. Des
 " Cloizeaux, dated March 18th, 1885 :

" ' Les anciens petits cristaux de Córdoba,
 " portant presque toujours la base, m'avaient
 " fourni plusieurs lames minces bien paral-
 " lèles à cette face et qui paraissaient per-
 " pendiculaires à la bissectrice *negative*, avec
 " plan des axes parallèle à la petite diagonale.
 " Mais les axes sont si écartées autour de
 " cette bissectrice et la dimension des lames
 " si exiguë qu'il ne m'a jamais été possible
 " d'apercevoir les anneaux dans l'huile. A travers les lames h¹, perpendic-
 " ulaires aux premières, mais d'une orientation nécessairement moins cer-
 " taine il est également impossible de voir les anneaux autour la bissectrice
 " *positive*. On peut donc *seulement dire* que les bissectrices *paraissent avoir*
 " l'orientation qu'elles auraient dans un prisme rhombique, mais il manque,
 " pour avoir une certitude *presque absolue* la constatation de l'absence ou
 " de l'existence d'une dispersion inclinée. Quant aux nouveaux cristaux



“j’ai fait un essai préliminaire et le hasard m’a fait détacher un angle d’un
 “petit cristal passablement translucide. Il portait 2 faces m et 2 faces
 “o($b\frac{1}{2}$). De la patience, un peu d’adresse et beaucoup de bonheur m’ont
 “permis d’arriver à une lame très sensiblement parallèle aux 2 arêtes
 “m : o, et passablement transparente, lorsqu’elle a été très amincie. La
 “masse est peu homogène comme dans les lames extraites des cristaux de
 “Córdoba et une bande noir opaque la traverse en son milieu. Il n’y a
 “donc rien d’étonnant à ce que les analyses faites jusqu’ici offrent des
 “différences dans les proportions de zinc, de manganèse ou de cuivre.
 “Plan des axes parallèle à la petite diagonale et bissectrice *negative* normale
 “à la lame et par conséquent parallèle à l’axe verticale ; malheureusement
 “les côtés du triangle (de la lame) n’ont guère que $\frac{3}{4}$ mm, mais il y a bien
 “d’espérer que quand on pourra sacrifier sans regret un ou deux gros
 “cristaux pour les réduire en plaques excessivement minces, on arrivera à
 “voir les anneaux dans l’huile, et par suite à s’assurer quel genre de dis-
 “persion ils présentent.’”

From the foregoing it has been observed that the descloizite of the Sierra Grande occurs in several varieties. In the first place there are :

a. Minute crystals from microscopic to about 1^{mm} in size, often sharply defined, varying in color, rarely orange-yellow, mostly from columbine-red to cherry-red and reddish-brown to pale clove-brown. Powder pale orange-yellow with a slight brownish tint. The crystals are isolated, but generally united in groups, sometimes forming incrustations, and are associated with calcite, quartz, iodyrite, vanadinite, pyrolusite and psilomelane, sometimes completely incrustated by the latter. Decrepitates on ignition and fuses to a grayish-black mass. This variety is represented by Fig. 2, and its composition is given in analysis a, 1, 2 and 3.

b. The other variety, Fig. 3 and 4, is found in larger crystals, some of which reach 8^{mm} in size. They are brownish-black or black, either opaque or, in transmitted light, of a reddish-brown color. Powder blackish-gray with a yellow tint. Decrepitates on ignition and fuses to a black slag.

As a rule, these crystals are very impure, being frequently penetrated by a large admixture of pyrolusite which, on dissolving in dilute nitric acid, remains behind.

These dark crystals appear to be the oldest of the vanadates, found at Lake Valley. They crystallize upon quartz and are associated with vanadinite, iodyrite, descloizite of a more recent origin, pyrolusite, psilomelane and calcite.

Analyses :

a. *Red crystals.*

a1. For a preliminary analysis 0.4769 grm red crystals, slightly coated with pyrolusite, was used. They gave 0.0630 grm pyrolusite and quartz which, deducted from the above, left 0.4139 grm pure descloizite which gave : 0.3140 grm PbSO_4 , 0.0048 grm CuO , 0.0704 grm ZnO , 0.0082 grm Mn_2O_3 and 0.0873 grm V_2O_5 .

a2. 1.1043 grm of nearly pure brownish-red crystals gave 0.0135 grm pyrolusite and quartz, giving 1.0682 grm pure vanadates, which gave 0.0017 grm Ag = 0.0006 grm Cl or 0.0226 grm vanadinite, which amount being deducted gave 1.0682 grm descloizite, furnishing 0.8396 grm PbSO_4 , less 0.0239 grm for vanadinite or 0.8157 grm., 0.0098 grm CuO , 0.0043 grm Mn_3O_4 , 0.0012 grm Fe_2O_3 , 0.2454 grm V_2O_5 , less 0.0044 for vanadinite or 0.2410 grm, no P_2O_5 and 0.0036 grm $\text{Mg}_2\text{As}_2\text{O}_7$. The zinc was lost.

a3. 0.9762 grm of the red crystals, which were freed with the greatest care from all vanadinite, gave 0.0060 grm quartz or 0.9702 grm pure material which gave : 0.0230 grm loss on ignition, 0.7426 grm PbSO_4 , 0.0121 grm CuO , 0.1727 grm ZnO , 0.0064 grm Mn_3O_4 , 0.0040 grm Fe_2O_3 , 0.0022 grm $\text{Mg}_2\text{As}_2\text{O}_7$ and no P_2O_5 . The V_2O_5 was determined by difference.

In the average of the three analyses the percentage of MnO in a1 is left out, because it is evidently too high.

Sp. Grav.=	a1	a2	a3	Mean.	Atomic ratio.	
PbO =	55.83 —	56.20 —	56.33 —	56.12 =	0.251	= 2.09
CuO =	1.16 —	0.90 —	1.24 —	1.10 =	0.014	} = 0.238 = 1.98
ZnO =	17.02 —	lost —	17.80 —	17.41 =	0.215	
MnO =	1.84 —	0.37 —	0.61 —	0.49 =	0.007	
FeO =	not det.—	0.10 —	0.19 —	0.15 =	0.002	} = 0.120 = 1.
As ₂ O ₅ =	“ —	0.24 —	0.17 —	0.20 =	0.001	
V ₂ O ₅ =	21.09 —	22.56 —	21.29 —	21.65 =	0.119	
H ₂ O =	not det.—	not det.—	2.37 —	2.37 =	0.136	= 1.13
			100.00	99.49		

c. Blackish-brown crystals.

c1. This analysis was made with the residue from which the best material was selected for c2 and c3, especially with reference to the amount of water present and the admixture of pyrolusite. 1.1004 grm gave on ignition a loss of 0.0290 grm. The residue, containing 0.0288 grm quartz, gave 0.0040 grm Fe_2O_3 and 0.0829 grm MnO_2 which were deducted as impurities. In the analysis c2 the chlorine was determined which represents the vanadinite, and from this the corresponding quantities were calculated for c1 and c3. 0.9847 grm, free from SiO_2 , MnO_2 and Fe_2O_3 would contain 0.0402 grm vanadinite or 0.9445 grm descloizite which gave : 0.7579 grm PbSO_4 less 0.0427 grm for vanadinite or 0.7152 grm, 0.0081 grm CuO , 0.1318 grm ZnO , 0.0326 grm Mn_3O_4 , 0.0029 grm Fe_2O_3 , 0.0068 grm $\text{Mg}_2\text{As}_2\text{O}_7$, a trace of P_2O_5 and 0.2052 grm, less 0.0079 grm for vanadinite or 0.1973 grm V_2O_5 .

c2. 1.1300 grm of the purest crystals gave : 0.0720 grm MnO_2 , 0.0015 grm Fe_2O_3 and 0.0032 grm quartz, giving for the vanadates 1.0533 grm, less 0.0442 grm vanadinite or 1.0091 grm descloizite, which gave : 0.8221 grm PbSO_4 , less 0.0470 grm for vanadinite, or 0.7751 grm, 0.0106 grm CuO ,

0.1469 grm ZnO, 0.0301 grm Mn_2O_3 , 0.0038 grm Fe_2O_3 , 0.2269 grm V_2O_5 less 0.0086 grm for vanadinite, and 0.0033 grm Ag = 0.0011 grm Cl = 0.0442 grm vanadinite. P_2O_5 and As_2O_5 , on account of their small quantity, were determined from the material of c2 and c3 and, after the deduction of the foreign substances, 2.0498 grm descloizite gave 0.0131 grm $\text{Mg}_2\text{As}_2\text{O}_7$ and 0.0015 grm $\text{Mg}_2\text{P}_2\text{O}_7$.

c3. Another portion of the same crystals was ignited strongly in a platinum crucible. 1.1560 grm gave a loss of 0.0518 grm. The mineral was fused to a black slag and the crucible badly injured. The fused mass was dissolved with difficulty in dilute nitric acid and gave 0.0018 grm SiO_2 , but contained no higher oxides of manganese. Taking the analysis cb as the basis for the subtraction of the impurities 0.0736 grm is obtained for MnO_2 and 0.0039 grm for Fe_2O_3 , giving for the vanadates 1.0767 grm less 0.0450 grm vanadinite or 1.0317 grm descloizite. 0.0736 grm pyrolusite has lost by strong ignition 0.0135 grm oxygen which, subtracted from 0.0518 grm loss by ignition, leaves 0.0383 grm for water. The analysis gave: 0.8444 grm PbSO_4 , less 0.0478 grm for vanadinite or 0.7966 grm, 0.0074 grm CuO, 0.1365 grm ZnO, 0.0241 grm Mn_2O_3 , 0.0034 grm Fe_2O_3 and 0.2312, less 0.0092 grm for vanadinite or 0.2220 grm V_2O_5 .

The analyses of the blackish-brown descloizite gave, therefore, as follows:

	c1	c2	c3	Mean.	Atomic ratio.
Sp. Grav. =	— —	5.882 —	5.814 —	—	—
PbO =	55.73 —	56.53 —	56.82 —	56.36 = 0.252	} = 2.12
CuO =	0.85 —	1.05 —	0.70 —	0.87 = 0.011	
ZnO =	13.95 —	14.56 —	13.23 —	13.91 = 0.172	
MnO =	3.21 —	2.77 —	2.23 —	2.74 = 0.039	
FeO =	0.27 —	0.34 —	0.30 —	0.30 = 0.004	} = 0.226 = 1.90
As_2O_5 =	0.53 —	0.48 —	0.48 —	0.50 = 0.002	
P_2O_5 =	trace —	0.04 —	0.04 —	0.04 = —	
V_2O_5 =	20.89 —	21.63 —	21.52 —	21.35 = 0.117	
H_2O =	3.07 —	not det. —	3.71 —	3.39 = 0.189	} = 0.119 = 1.
	98.50		99.03	99.46	

The analyses of the dark descloizites, after the subtraction of their admixtures gave approximations, agreeing very closely with the analyses of the best and purest red varieties. Both contain equal atoms of lead and zinc, the latter, in part, replaced by the isomorphous metals manganese, iron, and copper, the dark varieties containing a smaller quantity of zinc and a correspondingly higher of manganese. A very small quantity of the vanadium is substituted by arsenic and phosphorus. In the red crystals the hydrogen is about in the same ratio as vanadium, while the dark varieties contain more of the former, but as there is an uncertainty whether some of the evident admixtures do not contain water, not too much importance

should be attached to this higher percentage. The formula for descloizite corresponds to those of adamite, libethenite and olivenite, being :



Iodyrite.

Frequently associated with the vanadates of the Sierre Grande, and implanted in calcite in straw-yellow to bright sulphur-yellow imperfect crystals and crystalline masses. The best specimen which could be obtained was sent by the writer to Prof. G. vom Rath, who describes them as follows: "The crystals of iodyrite (yellow) are imperfect in their formation, nevertheless they allow one to determine their form as "a combination of the hexagonal prism and the basal plane. The descloizite shows large brown crystals of 4^{mm} in size and of older origin, "and smaller ones of light red color and of later origin, attached to the "iodyrite and calcite."

The spec. grav. of this variety was found to be 5.609, but the analysis was unfortunately lost, it was found qualitatively, however, that it was pure iodide of silver.

Another variety which is generally associated with the dark variety of descloizite and frequently implanted in it and leaving impressions on its planes, forms minute rounded crystals, rarely 1^{mm} in size, and shows sometimes little hexagonal prisms with basal plane; their color is mostly very pale greenish-yellow, seldom brighter. A qualitative test gave also pure iodide of silver.

University of Pennsylvania, April 16th, 1885.

The Chase-Maxwell Ratio. By Pliny Earle Chase, LL.D.

(Read before the American Philosophical Society, April 17, 1885.)

In 1872 (*Proc. Amer. Phil. Soc.*, xii, 394), Chase showed that the tendency of particles, in exploded gases, toward primary and secondary centres of oscillation, leads to a permanent *vis viva* of equilibrium which is $\frac{5}{8}$ of the *vis viva* of explosive projection, and that the synchronous action of the sun and the earth upon the oscillating particles furnishes a ready method for estimating the sun's mass and distance. He also showed (*Ibid*, p. 403-5), that the successive planetary positions in the solar system illustrate the influence of æthereal oscillations of a similar character. In 1875 he showed (*op. cit.*, xiv, 651), that the mean velocity of expanding gaseous pressure is $\frac{2}{\pi}$ of the corresponding constant velocity